VOLUME XX NUMBER 6 WHOLE NUMBER 157

THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

EDITOR
C. A. CHANT
University of Toronto, Toronto

ASSOCIATE EDITORS
J. S. PLASKETT
Director of the Dominion Astrophysical Observatory, Victoria, B.C.

SIR FREDERIC STUPART
Director of the Meteorological Service of Canada, Toronto

R. MELDRUM STEWART
Director of the Dominion Observatory, Ottawa

PUBLISHED MONTHLY
(*Ten numbers per year*)

July-August, 1926

PRINTED FOR THE SOCIETY
TORONTO: 198 COLLEGE ST.

FOREIGN AGENTS: WHELDON & WESLEY LTD.
2-4 ARTHUR STREET, NEW OXFORD STREET, LONDON, W.C.2

THE JOURNAL

OF THE

ROYAL ASTRONOMICAL SOCIETY OF CANADA

VOL. XX, No. 6. JULY-AUGUST, 1926. WHOLE No. 157

Articles PAGE

The Astronomy of the Bible - - *Cecil S. Quainton* 193

Observing Mars in Japan - - *Peter M. Millman* 198

The Importance of Water Vapour in the Atmosphere - - - - - *J. Patterson* 201

"The Facts Concerning Otto Struve's Work on Zeta Cancri (1840-1874)" *A. F. Miller; Otto Struve* 210

Notes and Queries

A False Report; Prof. H. C. Wilson retiring from "Popular Astronomy"; An Interesting Aurora; J. W. Fecker succeeds Brashear and McDowell - - *C.A.C.* 218

Meetings of the Society

At London, 221; at Montreal, 221.

Upon request, made previous to publication of article, contributors will be supplied free either with fifty copies of the issue containing the article, or with the sheets containing the article stitched in a printed cover. If separate reprints are desired the cost will be as follows:

	4 pp.	8 pp.	12 pp.	16 pp.	20 pp.	24 pp.
50 copies	$3 50	$6 50	$ 9 50	$10 00	$13 00	$16 00
100 copies	4 00	7 00	10 00	11 00	14 00	18 00
200 copies	4 50	8 00	11 00	12 00	15 50	20 00

Covers, extra, 50 copies, $1.50; 100 copies, $2.00; 200 copies, $2.50.

Business correspondence, remittances, etc., should be addressed to H. W. Barker, Treasurer of the Society, 198 College Street, Toronto.

Communications regarding Library matters should be addressed to the Librarian.

$2.00 per annum. Single numbers, 25 cents.

Subscription to the JOURNAL is included in membership fee.

FOR SALE—TWO TELESCOPES

6-in. Clark. Apply H. Westoby, 143 Glasgow St., Guelph.

4-in. Brashear. Apply Rev. A. H. Tyrer, 139 Colin Ave., Toronto.

THE JOURNAL
OF THE
ROYAL ASTRONOMICAL SOCIETY
OF CANADA

VOL. XX, No. 6 JULY-AUGUST, 1926 Whole No. 157

THE ASTRONOMY OF THE BIBLE*

By CECIL S. QUAINTON
Dean of Columbia Diocese, B.C.

THE Hebrew conception of the universe, as found in the Old Testament, is not scientific in the modern sense of the term. Hebrew cosmology has all the marks of a naïve primitiveness. The attitude of mind adopted by that ancient people in face of the great facts and forces of the world may have been one of awe, passing into adoration, but it was not one of critical enquiry. To pry too closely into the secrets of the Divine Government may perhaps have seemed to be irreverent, possibly dangerous. In any case, the mission of the Hebrews was not the giving of an interpretation of Nature, but the development and conservation of the doctrine of monotheism. In science and art, the Nile and Euphrates easily surpassed the Jordan. Not that the Hebrews were indifferent to Nature. The Psalms alone have to be read to see that they had a deep and genuine feeling for it—a feeling that never became the rank mythology of the early Greeks or the imaginative licence of the Aryans who poured into India and became the fathers of the Vedas. The Hebrews closely connected Nature with Jehovah. His will ruled it. His power was portrayed in it. Our knowledge of secondary causes, our ideas of law were unknown to them. Hence thier cosmology was simple, and

*A paper read to the Victoria Centre, R.A.S.C.

adapted to people who knew and cared little for mental analysis and inductive reasoning. Like the Phoenician sailors, the Hebrew shepherds observed the heavenly bodies, their awe at times deepening into worship. It does not necessarily follow that they borrowed star-worship from surrounding nations. It is not possible to fix precisely the extent of Babylonian and Egyptian influence upon them. Traces of such worship do appear in the Old Testament. They "worshipped all the host of heaven" (II Kings, 17: 16). And they were sternly warned against it: "Lest thou lift up thine eyes unto heaven, and when thou seest the sun and the moon and the stars, even all the host of heaven, thou be drawn away and worship them" (Deuteronomy, 4: 19). The surrounding nations easily passed from astronomy to astrology, and from astrology to astrolatry. The Hebrew prophets were so anxious to preserve monotheism that they threatened terrible judgments upon the star-worshippers. The Deutero-Isaiah sarcastically cries: "Thou art wearied in the multitude of thy counsels. Let now the astrologers, the star-gazers, the monthly prognosticators stand up and save thee from the things that shall come upon thee" (Isaiah 47: 13). Perhaps, this hatred of star-worship may account for the few traces of astronomical knowledge in the Old Testament.

The general arrangement of the world presented itself to the Hebrews as follows: the earth was a vast circular plane, on which the nations were dotted about, with Jerusalem perhaps regarded as a centre. Heaven was a large vault, supported by the extreme parts of the flat earth. Below the surface of the earth was a mass of waters, which with the lakes and seas formed the lower waters—the one being connected with the other by channels and caverns. Below the lowest waters was Sheol (often translated in the Old Testament, "hell"), the joyless, dim abode of shades. Here the departed, good and bad were housed. In later centuries, moral distinctions were introduced into Sheol, the good inhabiting the upper part ("Abraham's bosom"), and the evil dwelling in the Inferno of "the lowest parts of the earth". Above the earth was a vast space occupied by the air, and above that space was a vault of solidity (a "molten mirror", Job 37: 18), transparent in order to allow the light of the stars to pass through. This vault sup-

ported the store house of the upper waters which lay above, the vault being provided with something like flood-gates through which the rain passed (Genesis 7: 11). The picture therefore of the world as seen by the Hebrews was that of a rather flattened spheroid—the inferno in the depths, Sheol above, next the lower waters, then the earth's surface, with the air above the earth, superimposed upon which was the vault of heaven, with the upper waters above the vault.

The sun was regarded as ruling by day, and as coming forth from one chamber in the morning and returning to another in the evening. Its magnificence, its power for good or evil vividly impressed the Hebrews. The moon ruled the night, and, like the sun, was a power for good—"the precious things of the growth of the moon" (Deuteronomy 33: 14) and a power for evil (Psalm 121: 6). Its pale brilliance was an emblem of beauty—the Shulamite maiden was "fair as the moon". It is not certain that there are any references in the Old Testament to eclipses. "I will cause the sun to go down at noon" (Amos 8: 9). This may refer to its obscuration by dark clouds. "Sun, stand thou still upon Gideon, and thou Moon in the Valley of Aijalon. And the sun stood still, and the moon stayed until the nation had avenged themselves of their enemies. Is it not written in the book of Jashar"? (Joshua 10: 12, 13). The Revised Version has rightly put this in poetic form, for the "Book of Jashar", or the Upright, is a lost collection of Hebrew songs in which are enshrined the heroic deeds of the past. This much-controverted passage need cause no difficulty. It may be but a flight of fancy admirably fitted for a lyrical composition, or, if the poet regarded it as actual fact, may be accounted for by some natural phenomenon such as the dispersal of a storm cloud that threatened to blot out the sun and moon.

The stars are frequently alluded to in a general way. "The stars in their courses fought against Sisera (Judges 5: 20). This may be purely poetical (as in the statement, "the hills melted like wax at the presence of the Lord"), or may contain a reference to a belief in astrology. There are comparatively few references to particular stars. Some scholars have thought that the following reference, in which Isaiah exults over the coming ruin of Babylon, applies to the new moon: "How art thou fallen from Heaven, O

day star, son of the morning"! (Isaiah 14: 12). The Hebrew "Helel" however probably means a star. The Authorized Version translates it "Lucifer", but that is unsuitable. It is much more likely that there is here a reference to Venus. "Yea, ye (Israel) have borne Siccuth your King (obscure) and Chiun your images, the star of your God, which ye made to yourselves" (Amos 5:26, R.V.). "Chiun" (Hebrew, Kiyun) is probably equivalent to "Kairan", the name of Saturn amongst the Assyrians. There is a reproof probably here of the Hebrews for the worship of Saturn. In the course of a description of God's power in the marvels of nature, Job says, He "shaketh the earth out of her place (a possible reference to earthquakes) and the pillars thereof tremble, which commandeth the sun and it riseth not, and sealeth up the stars ... which maketh Arcturus, Orion, and Pleiades, and the chambers of the south" (Job 9: 9). In the Septuagint, we have "Hesperus" for Arcturus, and in the Vulgate, "Hyades". The Hebrew word for Arcturus is "Ayish", and occurs again in Job 38: 32: "Canst thou guide Arcturus with his sons"? The Revised Version has it: "Canst thou guide the Bear with her train"? And the stars that form the tail of the Bear might well be spoken of as its "sons", or "train". Some scholars think that "Ayish" might be translated Pleiades, sometimes represented as a hen with her chickens, but the balance of critical opinion is in favour of "the Bear with her train". "Orion" (Job 9: 9) is rendered "Arcturus in the Septuagint," and "Orion" in the Vulgate. It appears again in Job 38: 31: "Canst thou loose the bands of Orion"? There was a popular myth to the effect that Orion was a giant bound in chains in the sky. There is pretty general agreement that "Orion" is the right translation of the Hebrew "Kesil". "Pleiades" (Hebrew, Kimah) means a group, or cluster, and therefore the suggestion of a few scholars that "Kimah" should be translated "Sirius" is ruled out. "Canst thou bind the sweet influences of the Pleiades"? (Job 38: 31). "Sweet influences "is a poetic rendering, but not so accurate a translation as "bands" or "fetters", as of an ornament. The reference here may of course be of an astrological character. "Chambers of the south" (Job 9: 9) has been regarded as applicable to Canopus, and its constellation, but it is more likely that the reference is to

the whole group of constellations in the southern sky, or perhaps to the great spaces of the heavens of the southern hemisphere. The conditions would be satisfied by a constellation distributed between Argo, the Southern Cross, and the Centaur. "Canst thou bring forth Mazzaroth in his season"? (Job 38: 31). It is not quite certain whether the allusion here is to one thing or several things. "Mazzaroth" means the "scatterers" or "sprinklers", suggesting rain. Some scholars have thought there is a reference here to the Great Dog whose chief star is Sirius, a star that much attracted the ancients, others have thought the signs of the Zodiac are meant. The reference is probably to some star or collection of stars, subject to periodic appearances, and not always visible, that "came forth", or rose above the horizon at a certain season.

Finally: Hebrew Cosmology, meagre and primitive as it was, passed over substantially into the Christian church, and held sway until the advent of modern science, which has not yet entirely dispossessed the populace of what Carlyle called "Hebrew old clothes".

Victoria, B.C.,
April 1926.

OBSERVING MARS IN JAPAN

By Peter M. Millman

I AM writing this in an endeavour to show something of what can be seen by an amateur with only a small telescope. For the past number of years I have been impressed with the surprise evinced by the average person when I have mentioned the extent to which even a one-inch glass will reveal the heavens.

During most of the last seventeen years I have lived in Japan, and for the last ten have been interested in studying the heavens in a non-professional way. There, though at a latitude but little less than New York, the sky seems sometimes to be filled with stars seldom observed here, and the brilliant Canopus rises for an hour or more above the southern horizon to add his lustre to the brilliancy of the winter heavens.

I think that with the majority of amateurs there is more interest centred about Mars than any other single planet. This is probably on account of its close proximity, its detailed surface and the possibility of it being the abode of life. Mars has always held me with an interest far exceeding that of the other planets.

During the summer of 1924 I was staying in a little summer resort in the mountains at an altitude of about 1,500 ft. The mighty peak of Fuji, over 12,000 ft. high, towered over us on one side and a range of lower mountains on the other, enclosing us in a mountain chain. Since there was such a favourable opposition of Mars that summer, I wanted with my three-inch to see as much of it as possible. Using powers of 75 and 110 I was able to see the polar cap clearly from our yard; but although other darker markings were visible between the south pole and the equator they were so momentarily glimpsed that it was difficult to determine their form.

There is a pass at an altitude of about 3,500 ft. near where we were and a good military road over it. I thought I would get a better view from the top of the pass; so about a week before opposition, which was on the 23rd of August, my father and I took the telescope up the mountain on our bicycles and stored it at a small tea-house on the top.

The next thing to do was to wait for a fine night. Fortunately on the 21st of August the stars came out brightly at about ten in the evening after a light rain. Four of us started out with lanterns and began the climb. As the last mists faded away and we got higher, the stars shone more and more brilliantly; and these, coupled with the moon and the thousand glimmering lights of nearby towns, made a spectacle never to be forgotten. After several hours' steady climbing we reached the tea-house and wakened the old woman who kept it. The tea-house was full of labourers sleeping all over the floor. They were there to repair the damage done to the road by the great earthquake of the previous year.

I suppose the telescope box had been a subject of discussion among them, because when one happened to waken and saw me getting it out he immediately roused all the others, and there was a curious crowd of fifteen or twenty workmen around me as I put the machine up. They were of that simple peasant class, still untouched by the growing civilization of the cities; those who are so pleasant to meet and associate with. I gave them all a look at the moon and Mars, and told them a few facts about them while they listened very attentively. They were very much impressed by the mountains on the moon, and even pulled a couple of sleepy seven-year-olds out of bed to show them the sights. The youngest protested strenuously against this treatment. After they had all had a look I was able to get down to some observing.

I was extremely pleased to find that the polar cap stood out much more clearly, and that the dark markings took on a definite shape not to be mistaken. The strong marking, Syrtis Major, and the circular southern area, Hellas, were easily identified. I made

one drawing, and a little over an hour made another. The rotation of the planet was clearly evident.

In addition to the two features just noted, others stood out less clearly, the best being Eridania and Syrtis Minor. The markings exhibited none of the greenish tinge sometimes observable, but were a dark brown on a reddish background with the white at the pole in sharp contrast. On the whole it was a very beautiful sight and well worth any trouble that had been taken.

The clear sky did not last long, and the stars were soon dimmed or obscured. I packed away the telescope, to be taken down at a later date, and we went down through the gathering morning mists filled with fresh wonder at the beauty of God's Universe.

THE IMPORTANCE OF WATER VAPOUR IN THE ATMOSPHERE*

By J. Patterson

DRY air is composed of about 21 parts of oxygen, 78 parts of nitrogen and 1 part of argon, carbon dioxide and the rare gases. These proportions are constant and the same the world over; on this account it would be instructive to consider briefly what would be the character of the weather if these were the only constituents of the atmosphere. In such an atmosphere there could be only two climatic features—temperature and wind, the latter being caused entirely by the former. A dry atmosphere is approximately obtained in the polar and desert regions; in the former owing to the extreme cold, and in the latter to the lack of moisture-bearing winds. In either case, however, the conditions are profoundly modified by the surrounding areas, so that they give no true conception of the climate in a world without water vapour.

As just stated, there would be only temperature and wind to consider. The winds would all be due to the heating or cooling of the air, and consequently diurnal or seasonal in character. The diurnal winds would be strongest at the hottest time of the day due to the local heating of the earth, and then they would die down as the ground cooled. There would also be the heating as between the tropical and polar regions which would cause seasonal winds. In addition to this the mountains would also furnish temperature differences with corresponding winds.

The temperature would depend on the altitude of the sun and

---

*Presented at the meeting of the Royal Astronomical Society of Canada at Toronto, March 23, 1926.

the solar constant, except in so far as it would be modified by the winds bringing in colder air. This would indicate that a perfectly dry atmosphere would give a definite and constant climate which could be published with fair accuracy in a meteorological almanac. It is such an atmosphere that would satisfy the definition of winds given by many authors of physical geographies; for instance, "Winds are caused by the air becoming heated and rising, thus causing colder air to flow in and take its place."

It would appear then that a world of dry air would have an atmosphere in comparative equilibrium, and it is the injection of water vapour into the dry air that upsets the equilibrium and causes all the so-called vagaries of the weather—the changeable climate, seasons sometimes hot, sometimes cold, etc. In fact, water vapour is the stormy petrel of our atmosphere. With water vapour added to the dry air, instead of having only two climatic elements—temperature and wind—we have also clouds, fog, mist, rain, hail, snow, etc., and all the varied weather phenomena which make life possible on the globe. Water vapour, although only about one part in 400 of the atmosphere, thus plays a very great role in the economy of nature, and I wish to discuss some of its properties and results.

The earth receives its heat from the sun, from which all the energy required to produce our weather is obtained. This heat falling on a water surface warms the water and evaporates some of it, which passes into the air as water vapour. The question naturally arises, how much water can pass into the air or how much vapour can the air hold? This depends on several factors, and the first and most important is temperature. Warm air can hold very much more vapour than cold air; as an example, it has been found that air at 80° F. can hold five times as much vapour as air at 32°. Temperature thus imposes one limit on the amount of water vapour that the air can hold, but experiments have also definitely shown that there is another limit, depending on the kind of surface from which the water is evaporating. This can best be understood by considering the principles underlying evaporation.

The film of water that forms the boundary between water and

air requires a certain force to pierce it. A water molecule hitting this film cannot pass out unless its velocity is great enough to enable it to pierce the film; some have sufficient velocity to do so and pass into the air. The vapour molecules in the air are also moving with various velocities, and some of them have high enough velocity that when they strike the boundary film they pass into the water. There is thus an exchange of molecules going on all the time, some passing from the air into the water and some from the water into air. If more molecules pass from the water into the air than go from the air into water, evaporation is taking place; if as many pass one way as the other, there is no evaporation, and the air has all the moisture it can hold for that temperature. Should more molecules pass from the air into the water than pass out, the air is giving up its moisture to the water.

Experiments have shown that if a water surface is curved, as in a water drop, the force required for a molecule to pierce the film is less than if the surface is flat, so that more molecules can pass out or in if the surface is curved than if it is flat. Consequently the air can hold more moisture if the water surfaces are spherical than if they are flat. If then we are going to saturate the air with vapour we must specify, in addition to the temperature, the kind of surface exposed to evaporation. For instance, if the air over a flat water surface will hold an amount of water vapour represented by 100, it is found that for drops 5.5 ten-millionths of an inch in diameter it will hold an amount represented by 120, and for 1.2 ten-millionths of an inch it can hold an amount represented by 400, or four times as much as for a flat surface. If then we could put into the air small water particles of the latter dimension, evaporation would take place from them until the air held four times as much water vapour as it could if the surface were flat. Now it is always considered that the air is saturated when it has all the vapour it can evaporate from a flat surface; consequently, in the case of the very small drops, the air would have fourfold saturation, as the term is defined. In this case the air is said to be highly supersaturated, but the amount of supersaturation is not large for curved surfaces until the diameters become very small.

The amount of water vapour that the air can hold thus depends on two properties, the temperature of the air and the sizes of the water surfaces. It is found that a cubic mile of saturated air at 0° F can hold only 5,000 tons of water vapour, at 32° or freezing point it can hold 22,000 tons, at 50° 43,000 tons, and at 80° over 110,000 tons. We see then that the amount of water vapour in the air increases very rapidly with temperature, but if the total amount of water vapour in the atmosphere were condensed or precipitated as rain it would average only 0.80 of an inch over the globe, so that the total amount would not be a very heavy rainfall for the whole world.

So far we have been considering the amount of moisture the air can hold, but as a rule the air does not contain all the moisture it is capable of holding, and our feelings tell us if the air is damp or dry, that is if it contains much moisture or little. This property of the air is known as the relative humidity, which is the percentage of vapour in the air compared to the amount required for saturation. Thus if the air holds half as much vapour as is required for saturation the relative humidity is taken as 50; if it is three-quarters saturated, it is 75; and if saturated, 100; while if it should contain no moisture the relative humidity would be zero.

As the temperature and the kind of water surface exposed to evaporation determine the amount of moisture the air can take up, they must also be the chief factors in the reconversion process.

It has been shown that the amount of water vapour the air can hold increases rapidly with increase of temperature and that the air generally contains less moisture than is required to saturate it. In the conversion of the vapour to liquid we must first of all get the air at least saturated. This can be done by cooling until it reaches a temperature where it has all the moisture that it can hold. This cooling is obtained by the air rising and thus expanding. As the moisture is carried along with the air in its ascent it reaches a level where the temperature is reduced to the saturation point or even many degrees below, giving air that is highly supersaturated if necessary. Thus temperature plays a very great

part in the process of supplying the earth with moisture, as it enables the air to hold large quantities of vapour at a comparatively high temperature at the place of evaporation, and then, by the air rising and cooling until it is saturated or supersaturated as the case may be, it becomes in a condition to appear as cloud or rain. We have still, however, to find the means by which the vapour can condense after the air is saturated.

It has been pointed out that, if water drops 1.2×10^{-7} inch diameter are in the atmosphere, the air can evaporate them until it has four times the amount of vapour that it can hold if evaporation is from a flat surface; consequently, in considering the reverse process, vapour could not condense on such particles unless it held four times as much vapour as is required for ordinary saturation. It would thus appear to be a difficult process to get the vapour converted into water, because one of these small particles of 1.2×10^{-7} inch diameter contain 20,000 molecules, and if the vapour had to condense by single molecules uniting into a drop and then 3, etc., it would require very much more than fourfold saturation before condensation could take place.

Water vapour does condense into water, as we all know, and there must be some mechanism in Nature that brings this about. Many years ago Aitken showed that condensation does not necessarily take place when the air by cooling becomes saturated; in fact, he showed that if the air was pure it was necessary to supersaturate it very considerably before fog could be produced, but that if dust particles were present fog was produced with much less supersaturation. Later C. T. R. Wilson showed that if ions were present the fog would form on them if fourfold saturation was produced. This then gave a clue to the mechanism by which the vapour condensed to form fog or cloud particles, but it required cooling the air until there was fourfold saturation.

This idea has lead to many and various methods of producing rain, by supplying the air with dust or electrified particles of sand or dust in order to provide the means for the vapour to condense on them; this in some mysterious way would then produce rain.

There are always myriads of dust particles in the air, and as soon as vapour condenses on them they naturally increase in size, and, as it has just been pointed out, the larger the diameter of the particle the less the vapour that is required to saturate the air; consequently the big drop will grow at the expense of the smaller drop or dust particle. Thus, once the air is cooled sufficiently to form fog particles, the dust particles take no further part in the process. The addition then of more dust particles would not assist Nature in her work; in fact, the better plan would be to take some of the dust out of the air.

In the above explanation of the process the meteorologist has always been confronted with the lack of experimental evidence of the air becoming as highly supersaturated as the theory required before fog could be produced. As all experiments show that in pure air, or even dusty air, there must be a high supersaturation before fog can form, and if the fog does form without supersaturation, there must be some other mechanism at work which enables this process to take place. In order to explain this we shall digress a moment to consider some other properties of the air and the suspended matter in the air.

In this country we are all very familiar with the wood in the interior of our homes drying out in the winter, due to the very dry air or low humidity, and swelling in the summer when the humidity is high. Many substances possess this property, and it is due to their giving out moisture and shrinking in the dry air and then taking up moisture which causes the substances to swell when the humidity increases. Such substances are said to be hygroscopic. Most vegetable substances are hygroscopic, and it is known that there are very many small particles of such substances in the air. They would absorb the vapour if the air was damp, and thus increase in size, so that they could become the nuclei on which the vapour could condense without the air having to be supersaturated. In addition many substances, such as common salt, calcium chloride, sulphuric acid, sulphur dioxide, etc., have a great affinity for water, and will absorb it whenever they can get it. Now if particles or molecules of these substances were in the air they would take

up moisture even if the air was not saturated, and in doing so would increase in size. Such particles would form efficient centres about which the vapour could condense. It appears, therefore, that these hygroscopic substances furnish the nuclei on which the vapour can condense without the air becoming supersaturated, and that the dust and electrified particles have no part in the process.

The first operation then in the conversion of vapour into rain is the formation of fog particles by the condensation of the vapour on the hygroscopic nuclei. These fog particles are very small and fall very slowly, only about 35 feet per hour, so that it would take a long time for them to reach the ground. For these fog droplets to grow it is necessary to supply them with more vapour. This is brought about by the pressure distribution, and it now appears that the warm moisture-laden air is in many cases undercut by a cold current, which forces it to rise until it is cooled to the saturation point, when the fog appears, and as this stream of moisture-laden air is being poured into the cloud region the moisture required to enable the fog particles to grow is provided, and consequently the drops grow until they are big enough to fall as rain. As long as this supply of moisture-laden air is maintained the rain will continue to fall, but as soon as it is cut off the drops can no longer grow and the rain ceases. Thus it is not sufficient merely to cool the air until the saturation point is reached to get rain, but the continuous supply of vapour must be provided in order that the fog droplets may grow. Rain drops are of many sizes, from about a hundredth of an inch in diameter for the drops in a drizzling rain to those about a fifth of an inch in diameter in a heavy thunderstorm. The drops, owing to the resistance of the air, fall at a constant velocity, and the greatest velocity with which a drop can fall is about 25 feet per second, while the small drops such as occur in a drizzle take half a minute to fall that distance.

As already stated, the moisture-laden air is forced to rise until it is cooled to the saturation point, and thus vertical, or ascending, currents, are produced in the atmosphere. These currents may be quite gentle, as when a light, steady rain is falling, but again they may become so great that the drops cannot fall through them. As

the greatest velocity that a drop can have is about 25 feet per second, it follows that if there should be an ascending current of this velocity it would simply hold the drop up, while if the velocity was greater than this it would carry the drop upward. In violent storms this actually happens, and the upward rush of air may be so great that no drops can fall through them, but are broken up and carried upward; they may be carried outward at the same time to a region where the vertical currents are weak and so permit the drops to fall.

At times, if the storm is very violent, the currents are so strong that the drops are carried up to great heights, where the temperature is far below freezing. Experiments have shown that an undisturbed drop can be cooled to 4 below zero Fahrhenheit without solidifying, but at this temperature it solidifies into a ball without crystal structure. This gives us the explanation of the character of the hail stones and the mechanism by which they are produced. The violent upward currents carry these drops upward until at a height of 20,000 feet they reach a temperature of 4 below zero, when they instantly solidify; if they are carried up higher than this any vapour condensing on the solidified drops would be in the form of snow. As in high surface winds there are gusts and lulls, so are there gusts and lulls in the vertical currents, and when a gust is succeeded by a lull these hail stones fall. During the descent any supercooled drops that the hail stone strikes will solidify immediately on the drop, and at the same time imprison a certain amount of air, so that by the time it reaches the bottom of the supercooled region it will be a ball of soft white ice. It then falls through a region where there is abundance of water vapour and rain drops, and as the hail stone is much below the freezing point the water drops will freeze on it without imprisoning air, and so will form around the soft ice core a shell of clear crystalline ice. If another uprush of air occurs, the stone is again carried up and again falls. This process may be repeated several times until the stone is at last heavy enough to fall through the uprushing currents and reach the ground. The size of the hail stone is thus a measure of the strength of the upward currents.

I wish now to deal briefly with another very important point in connection with water vapour. As I have already explained, there are many hygroscopic substances that take up moisture from the air when the humidity is high and give it out when the humidity is low. Most vegetable substances and many animal substances are of this nature. One of the best examples of this is the hair. It is one of the best means of measuring the humidity that we have. It expands with increasing humidity and there is very little lag, that is, if the humidity is increasing, the length of the hair is also increasing at the same rate, or it is taking up moisture at the same rate of increase. If now the humidity gets very low, these hygroscopic substances give out their moisture and get very dry; in fact, they may get so dry that they will burn instantly fire is applied to them; but, on the other hand, if the humidity is fairly high, these same substances have the corresponding amount of water in them, and before they can burn readily they must be dried out.

Perhaps you will have recognized the significance of this. It was for a long time unknown what constituted a fire hazard in the forest. It was generally assumed that it was dependent largely on the temperature, but recent investigations have shown that it is not the temperature but the humidity that determines the fire risks. You can see why this is so. When the air gets very dry, the humus on the floor of the forest and all the dry material there also become very dry on account of their hygroscopic nature; and when the humidity falls below about 30% it becomes so dry that a spark of any kind will send it ablaze. In such conditions the fire spreads like the term that is used to describe it—wild-fire. This condition usually obtains from the middle of the afternoon until about dusk, when the humidity begins to rise on account of the cooling of the air, and as the humidity approaches saturation the fire generally dies down. Humidity then is now being recognized as one of the chief determining weather factors in the fire hazard, and consequently its importance is being more fully recognized. This is one of the elements for which forecasts are now being made, and in the work of preserving our forests its importance is very great.

Meteorological Office, Toronto.

"THE FACTS CONCERNING OTTO STRUVE'S WORK ON ζ CANCRI (1840-1874)"

A. F. MILLER

I HAVE been doubtful as to the propriety of occupying with *controversy*, space in THE JOURNAL (designed solely for the dissemination of scientific knowledge). However lest any might imagine I share *Dr. Johnson's* opinion as to the unwisdom of answering noisy critics,[1] I shall reply as briefly as I can to the communication of the Messrs. Otto and Georg Struve which appeared in the number for March last.

At the outset I wish to correct two errors in my paper as printed in the December number of THE JOURNAL. First: by a copyist's slip the words, *of his requirement*, which should have followed the words "full particulars" (p. 276, line 32), were left out. Second: depending on my recollection, I wrongly placed the deposit of the *pli cacheté before* Flammarion's application to Struve, whereas Flammarion states it was deposited *before the presentation of Struve's communication to the Academy*. Needless to point out, both these errors are prejudicial to Flammarion rather than the converse.

While it would not be very difficult to answer and, where necessary, refute, the statements of the Messrs. Struve, I shall not spend time over irrelevant matters, but only deal with the few points of consequence.

The grandsons of Prof. Otto Struve have been good enough to secure evidence that during several years (1862 to 1874) a correspondence of a scientific nature, on friendly terms, had gone on between two men, the (then) greater man obligingly supplying

[1] "Answer them! Not I indeed; *that is just what the fellows want.*"—Boswell's *Life*.

information asked for by a correspondent in France (then almost unknown), whose graceful acknowledgments showed how much he appreciated the favours granted. It is evident from Flammarion's letter of November 20, 1873 (though we have only been given a résumé of it,[2]) that he then asked for the observations of ζ Cancri (along with some other stars), and that Struve's reply must have led him to believe he would be given those of the Cancer object when "corrections personnelles" had been made. Relying on what his correspondent had written, Flammarion wrote again to Struve on April 29, 1874, repeating more pointedly his request for the observations of "ζ Cancri *A*, *B*, et *C*," saying, "*J'ajoute ce dernier groupe, afin que si corrections personnelles dont vous m'avez parlé sont faites maintenant, vous ayez le bonté de me l'envoyer. C'est celui auquel je tiendrais le plus à cause de son importance comme system triple.*" In writing these last words Flammarion *directed his correspondent's attention specially to the particular object of his own research*, thus showing how complete was his confidence in the great man from whom he was asking information to assist him in carrying it on.

Just here I may point out that the Messrs. Struve have informed us that Prof. Otto Struve had accumulated no less than "*Seven and a half pages*" of observations of ζ Cancri[3] prior to Flammarion's second application for some of these.

"*The Russian Astronomer did not reply!*"[4]

"What!" said an impartial reader of the Messrs. Struve's statement; "Seven and a half pages of observations, yet not one observational 'crumb' to spare for the poor man begging at his gate!" Sad, but true, good impartial reader. The Russian Astronomer *did not reply*.

And as a matter of fact *he never replied!* never gave Flammarion

---

[2]It would have been preferable had the grandsons given us the letters of November 20, 1873, and April 29, 1874, *in full*, instead of a mere outline of the former, and *a part* of the latter, supplemented by their résumé of the omitted portions. (However I am obliged to them for having given even this fragmentary information.)

[3]*The Journal*, March 1926, p. 87.

[4]*Catalogue des Etoiles*, p. 49; *Les Etoiles*, etc., p. 338.

any of those observations of which he had told him.[5] One naturally would ask: Why did Struve not reply? Doubtless he had reasons he thought good, but what he may have *thought* (unless explained) cannot justify to impartial persons a course of action so entirely different from his previous attitude toward Flammarion, and the *interest he had shown in his querist's work.*[6] Struve may have thought that as the observations were *his*, he had the right to withhold them if he so wished. He would be clearly wrong there, for the observations made in a STATE OBSERVATORY are intended for the advancement of science in general, and not as perquisites of the Director.[7] However, allowing that to pass, the conclusion forces itself upon us that he had already resolved to make use of them for his own personal benefit. But in that case his silence is even less justifiable. If that were so, he ought then certainly to have told his correspondent *at once*: "I cannot (or will not) impart to you my observations of that particular object," leaving the latter free to obtain information elsewhere, and himself (Struve) at liberty to communicate with the Paris Academy, or any other, as he might see fit. In that case the utmost that could have been said would have been that Struve was *not altruistic* (and indeed altruism is a somewhat rare virtue). However, not to condemn all men alike, I cite one case in rather marked contrast. The nobleminded and generous BURNHAM, when asked by Flammarion for the measures of a "double", which the latter wished to obtain, made the measurements the very next night, and forwarded them to the applicant by return mail, with the additional information that he had found *the comes itself was double*;[8] an important original discovery. But BURNHAM had so many such discoveries to his credit (while still only a law-court reporter) it was not necessary for him to keep them secret till he could present them to an *Academy*.

---

[5] *The Journal*, March 1926, p. 88.

[6] *Ibid.*, p. 89 (second line).

[7] For instance, the case of Newton and Halley, who obliged Flamsteed to give up his observations of the moon, though made with his own instruments and recorded in books purchased out of his own slender means. The poor and aged Astronomer Royal had designed to *sell* them for the benefit of his wife who would be left in penury when he died.

[8] *Les Etoiles*, p. 172; *The Journal*, December 1925, p. 277.

But to resume the subject in hand: We have been informed by the grandsons that "Five letters from Flammarion were found" in Struve's scientific correspondence.[9] No doubt whatever that four of these had been answered; equally certain *the fifth was never answered.* Flammarion had every reason to suppose that a courteous letter written by an astronomer and a gentleman in a foreign land, to the Director of the Poulkova Observatory would bring a reply of *some sort* from the eminent man to whom it was addressed (who had also invariably answered former letters). But no reply was vouchsafed. Reposing confidence in the good faith of the man who had on four previous occasions treated him with the consideration one man of science is supposed to accord to another, he awaited a response to his request, and delayed communicating to the Academy the results at which he had arrived from information obtained from other sources, solely because he proposed to verify these by "observations the most accurate available".[10] Instead of that, however, and after he had been allowed to depend on vain expectations, the outcome of confidence unfortunately misplaced, *during eight months*, he learns *then* with astonishment and consternation that the eminent and famous man of science in whom he had trusted so implicitly, had calmly thrust him into the background by a publication in the *Comptes Rendus*, followed directly after by a communication to the *Paris Academy.* Possibly Struve adopted that course suspecting Flammarion might be contemplating some announcement which might anticipate him in priority. Flammarion believed, not without some grounds, that the special interest he had shown in regard to ζ Cancri, had drawn to that object the attention of Struve, who with so many stellar orbits to investigate might otherwise have failed to select that one.[11]

The Messrs. Struve assert that "two discoveries so different in nature leave no doubt as to their independent origin." They are referring to a supposed discovery of "the existence of a fourth attracting body." They fail to see that when speaking thus, they

---

[9] *The Journal*, March 1926, p. 88.
[10] *Ibid.*, p. 88 (last paragraph).
[11] *Les Etoiles*, p. 338 (last line).

are abandoning any claim for Otto Struve so far as the complicated movements of *C* are concerned, resting their case entirely on the discovery of "the fourth attracting body." It is certain, however, that Struve had not then actually *seen* such a body, but only *inferred* its existence from those movements. Flammarion says: "*M. O .S. emet l'idée,*"[12] which "idea" was due to the cause just stated; and it would not demand the skill of a LeVerrier to perceive that the complicated movements graphically shown in *Les Etoiles* (pp. 339, 340, 341), could only be accounted for on the assumption of at least one (if not more), perturbing body or bodies. Incidentally—the Messrs. Struve would explain Otto Struve's application to the Paris Academy on the ground of Le Verrier's partiality toward the investigation of perturbations. Struve *did* have his communication presented by LeVerrier, but thereafter, that great investigator showed not the slightest interest in the subject. As every one knows, his specialty was planetary perturbations. But before passing on I must point out that the Messrs. Struve are entirely wrong in using the expression, "two discoveries different in nature", *both* astronomers in their communications having dealt with the movements. In which regard quite recently an eminent astronomer did not recognize Struve's claim to priority, when saying "*en prétendant revéler au monde savant,*" etc.[13]

And now, to terminate, so far as I am concerned, a discussion devoid of the slightest scientific utility, regarding what I have long regarded as "*Une Ténébreuse Affaire*",[14] I must point out to the reader that he should, before attempting to reach a decision on the right or wrong of the matter, read what Flammarion has said on this subject in his two important works: *Catalogue des Etoiles Doubles et Multiples*, Paris, 1878 (p. 49), and, *Les Etoiles et les Curiosités du Ciel.* Paris, 1881[15] (pp. 337, 338, 339, 340, etc.). The former has a short note on the subject of Flammarion's complaint against Otto Struve; the latter relates the incident at some

---

[12]*Catalogue*, p. 49.

[13]*L'Astronomie*, Juillet 1925, p. 356.

[14]The title of a novel of *De Balzac.*

[15]It was suggested I should have Flammarion's statements reprinted in *The Journal.* I did not feel justified in doing so to the exclusion of papers awaiting space.

length; both call attention to the essential fact that ***Struve did not reply.*** I must specially direct the reader's attention to the four ***very renarkable coincidences*** which the author enumerates categorically (and to which others might be added, but enough has been said). As the works I have mention were published nearly half a century ago (and may possibly be out of print), readers of *The Journal* might not easily have access to them here. To any such who may be interested in the matter I would say, that my own copies of both works shall be placed at the disposal of persons resident in Toronto on application through the Library of the R.A.S.C., while to non-residents I will *send copies* of the passages, on request through the Library. The Messrs. Struve endeavour to avoid the grave charges which the passages in question contain, and the fact that they remained unnoticed by Prof. Otto Struve, though twice mentioned therein by name, by asserting that only the former work is *a scientific* publication. However, *Les Etoiles* is quite as justly entitled to be regarded as a scientific work, though the vast amount of accurate information it comprises is stated in popular language. Indeed the Messrs. Struve might correct by its aid one of their errors, for they have attributed to "since the time of W. Herschel", the knowledge that ζ Cancri is a triple star, whereas the 3rd star was discovered by Tobias Mayer in 1756, and he made 11 measures of it (not very accurate ones, of course).

In concluding, I beg to assure the Messrs. Struve that their suggestion that I might "excuse" myself on the ground of having utilized anything put in print by the eminent Secretary-General of *La Société Astronomique de France*, is an entirely unwarranted insinuation. Some other little personalities in which they have indulged I pass over.

COMMENT UPON THE ABOVE ARTICLE

By Otto Struve

IT is indeed to be regretted that Mr. Miller has made such an important mistake as to omit the phrase "of his requirement", without which readers of his original statement were left to believe

that Flammarion had sent "full particulars" to Otto Struve concerning some discovery that he had made in connection with Zeta Cancri. It is especially unfortunate that through this omission the statement was left in such form that it appeared to allege that Otto Struve had used those "full particulars" in order to present them to the Paris Academy of Science as "an original discovery of his own", and was by that act shown to have been guilty of "dishonorable conduct". Such a statement, as we have shown in our previous communication, could only be construed as an utter misrepresentation and misstatement of fact.

Mr. Miller still asserts that "Flammarion directed his correspondent's attention specially to the particular object of his own research". Obviously, this could not have been the fact, since, as we have already made clear in our first paper, Otto Struve had given especial attention to Zeta Cancri since the year 1840. The letters of Flammarion to Otto Struve contain no "confidences" and give no information whatever concerning Zeta Cancri. It is therefore both useless and meaningless in this connection that Mr. Miller indulges in such remarks as: "showing how complete was his confidence", "reposing full confidence", "the outcome of confidence unfortunately misplaced", and "he had trusted so implicitly".

Statements which are given without any *proof* whatever, and which are, furthermore, incapable of being proven, are decidedly out of place in scientific literature. This applies to Mr. Miller's repeated and emphatic assertions that "Struve never replied!" Flammarion's statement that no answer was *received* certainly cannot be taken as absolute proof that an answer was not *sent*. Neither is it good judgment to make hasty conclusion that a dishonest motive lies behind a letter unanswered. Any *astronomer* will understand that not only would it have been Otto Struve's full right but his duty as director of a *State Observatory*, to do with his observations what in his (and not in Mr. Miller's) judgment was best for the advancement of astronomy.

Concerning the different nature of the separate results of Otto Struve and of Flammarion, attention is again directed to Flammarion's own statement (which is more to the point than Mr.

Miller's explanation): "avec certaines différences, néanmoins, car M.O.S. émet l'idée d'un quatrième corps, invisible et perturbateur de C".

Referring to Mr. Miller's idea that we are "abandoning any claim for Otto Struve", etc., I wish to make it emphatic that I have no interest whatever in the matter of priority, except in so far as Mr. Miller attempted to base upon it his accusation of dishonesty.

Perhaps the strongest illustration of the incompetence of Mr. Miller to function in the capacity of historian, or to make use of authentic sources in forming his conclusions, is his pointed suggestion (refer to the next to the last paragraph in Mr. Miller's article, this issue) that "indeed the Messrs. Struve might correct . . . . one of their errors" and proceeds to inform us that the star was discovered to be triple by Tobias Mayer in 1756. "Les Etoiles" is not contained in the scientific library to which I have access at the present time, and I am therefore unable to correct myself "by its aid" as suggested by Mr. Miller. But if the reader will refer to page 88, Volume I, of *The Scientific Papers of Sir William Herschel*, edited by J. L. E. Dreyer (1912), he will have no further doubt that our former statement was correct. Tobias Mayer had believed Zeta Cancri to be a double star, and it was William Herschel who discovered it to be triple, on November 21, 1782. The story of the discovery of Zeta Cancri is told in popular language on page 198 of Miss Clerke's "The System of the Stars".

Unfortunately it was not possible, in the short time allowed me for this reply, to submit the matter to Professor Georg Struve. However, he previously gave me his permission to act for both of us, if circumstances should require.

Pasadena, California.
June 25, 1926.

Note.—This closes the above discussion.—Editor.

NOTES AND QUERIES

Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.

A False Report

"The rumour of the 42-inch discs for the 41-inch Russian objective having been found useless, is a fabrication."

This statement is contained in a letter from Mr. C. Young, Manager of Sir Howard Grubb, Parsons & Co., Newcastle-on-Tyne.

In our issue for April-May there appeared a photograph of a portion of the Optical Works of the above firm. Prominent in the picture were the two discs of glass for the Russian refractor. At the close of a note describing them, the statement was made that the latest information was that they had been found to be useless. This was based upon a note in *Popular Astronomy* for May, which had been supplied by "Science Service Correspondence, Leningrad."

It is very gratifying to learn that the report was false.

Professor H. C. Wilson Retiring from "Popular Astronomy"

Dr. H. C. Wilson has retired from the directorship of Goodsell Observatory of Carleton College, Northfield, Minn., which position he has held for sixteen years, and also from the editorship of *Popular Astronomy*. He will spend a year in California, partly at the Mt. Wilson Observatory, after which he will return to Northfield to spend his time in research. Prof. E. A. Fath succeeds Dr. Wilson as director of the Observatory, and he and Dr. C. H. Gingrich will conduct *Popular Astronomy*. In this they are no novices, as they have been associate-editors for many years.

This change can hardly be described as a *rest* for Dr. Wilson, though he well deserves one. The present writer wishes to com-

pliment him on the state of efficiency to which he has brought his highly-esteemed publication, and upon the activity of his mind and body, as shown in his devotion to research.

An Interesting Aurora (By A. F. Hunter)

An unusual aurora that attracted much attention, and was noticed in the newspaper press, occurred on the night of June 1 and 2, 1926, and deserves some notice in the Journal. The writer, at Toronto, saw it first at 12.30 a.m., just after midnight, and kept it under observation for about two hours in the early morning of June 2, on account of its unusual character. (Afterwards it was learned that it had been visible for two or three hours before he first saw it.) When first observed by him, and for a long time afterward, it was rapidly flickering and dancing, while the upright streamers were quickly changing their positions and brilliancy. There was no distinct arch, when first seen. The pulsations came up from the northern horizon, rapidly following each other. The display of streamers was general over the whole sky. The flickering was much diminished by 1.30 a.m. A distinct and interesting arch had been formed in the north by 2.15 a.m., quite brilliant and consisting of streamers, but there was no observable flickering by this time.

Note by Editor.—Mr. J. W. Long, of Toronto, gives the following estimated positions of the focus of the streamers:—June 1, 10.45 p.m., daylight saving time (or 9.45 p.m. E.S.T.), near Epsilon and Rho Boötes, about R.A. 14 h. 34 m., Decl. 30° 15′ N.; June 2, 12.40 a.m., D.S.T., at the middle of the "Keystone" in Hercules; June 2, 1.00 a.m. near Epsilon Coronae. The second observation he considers the best. These positions will be compared with the magnetic zenith later.

J. W. Fecker Succeeds Brashear and McDowell

The late G. L. Fecker was for years with Fauth and Co., of Washington, D.C., and as early as 1894 distinguished himself as a designer and maker of optical instruments. The Fauth interests were later owned by Saegmiller.

After spending four years in Washington, G. L. Fecker went to Warner and Swasey, in Cleveland, and remained until 1915.

He was succeeded in the work by his only son, J. W. Fecker. Shortly after the death of G. L. Fecker, in 1922, J. W. Fecker resigned his position with The Warner & Swasey Company to engage in the business of designing and constructing optical instruments in entirety, that is, both the mechanical and the optical parts, thereby opening wider opporutnities for original work.

In November, 1923, a few weeks before his death, Mr. McDowell visited the Fecker shop in Cleveland and invited Mr. Fecker to Pittsburgh to combine the Fecker business with his, Mr. Fecker to take full active charge, thereby relieving Mr. McDowell of some of his numerous and difficult tasks. Before negotiations were completed, Mr. McDowell died suddenly. Mrs. McDowell continued the business successfully as long as her health permitted. Upon her death, the estate naturally sought relief from the situation in which it found itself, having to run a scientific business with no guiding head active in the office and shop. The first thought was to take up negotiations started by Mr. McDowell, and these were satisfactorily closed in May.

J. W. Fecker, son of G. L. Fecker and Emma B. Fecker, is descended from families whose chief work has been in optics, for optical manufactories established by his predecessors on both sides are still flourishing in Europe. Hence it was the ambition of both parents to have their son establish himself in the work and to make scientific advancement, should it be given to him to do so. Accordingly, he received theoretical and practical training under his late father, and other theoretical training at the Case School of Applied Science, Cleveland, of which he is a graduate.

The present organization has kept the experienced men trained by Dr. Brashear and Mr. McDowell, and has added to these the men from the Fecker shop.

The plan at present is to continue the optical work formerly done by Brashear and McDowell, and to make, besides, mechanical mountings for any instruments required; also to make optical instruments not heretofore undertaken by either of the two concerns, nor by the Cleveland concern with whom they cooperated.

C. A. C.

MEETINGS OF THE SOCIETY

AT LONDON

The April meeting was held in the Science Building, University of Western Ontario, on Friday, April 9, 1926, at 8.15 p.m. Dr. H. R. Kingston spoke on the "Constitution of the Stars." Lantern slides were used to show how the rays of light are bent when passing from one medium into a medium of a different density. Dr. Kingston explained that light consists of a wave motion and is very complex. When the light from the sun passes through a glass prism the rays of light of different frequencies of vibration are separated and a coloured spectrum is produced. Experiments were performed showing the spectra of various substances. The following laws were demonstrated:—

1. A solid or a liquid or a gas under high pressure produces a continuous spectrum.

2. A gas not under high pressure produces a bright line spectrum.

3. A relatively cool luminous gas between the source and the observer produces a dark line or absorption spectrum. Dr. Ainslie of the University assisted in the demonstrations on the spectrum.

A very successful combined picnic and observation meeting was held on Saturday, June 19th, on Mr. W. E. Saunders' farm, just outside the city of London. An image of the sun was projected on a screen by means of a telescope, and the members present were able to get a very clear view of some large sun spots. Drawings of these were made. Observations were also made of the moon and of the rings of Saturn.

E. T. WHITE, *Sec.-Treas.*

AT MONTREAL

February 18, 1926.—In the absence of the President and Vice-President the chair was taken by Dr. A. S. Eve.

New members were elected as follows:—

Dr. H. T. Throsby, Miss Ada Hird, Miss Marion Low.

The lecturer was Mr. R. G. Madill, Assistant Magnetician, Dominion Observatory, Ottawa, his subject being "The Earth's Magnetism".

The wide importance of the study of Magnetism was stressed and a

brief survey of its history was given. The lodestone, 7th century B.C.; Polarity was known by Chinese 2634 B.C., rediscovered in west in 10th century A.D.; compass used in Japan 7th century A.D.; floating compass with graduated scale developed by Peter Peregrinus, 1269; Italians claim first mariner's compass made by a native of Amalfi, 1302; recent improvements were Kelvin's multiple needle and modern aperiodic forms.

Magnetic variations were noted by Columbus and Cabot. About 1500 sundials with magnetic needles affixed were used to determine magnetic declination. In 1576 Magnetic Dip was measured at London by Norman.

The publication in 1600 of William Gilbert's "De Magnete" first drew attention to the cause of the orientation of the lodestone being the magnetism of the earth itself.

Changes in magnetic declination were established by Gellibrand, who measured a 7° change at Deptford between the years 1580-1634.

The charting of magnetic declination over ocean areas was undertaken in 1700 by Halley, and has since been an important feature of the work of the British Government in aiding navigation. The U.S.A. Government undertook a magnetic survey of Canada prior to 1900, but since 1913 the Dominion Observatory has been alone responsible for the accurate and valuable work done throughout the Dominion.

With this introduction the lecturer proceeded to discuss many aspects, practical and theoretical, as outlined in his own summary as follows:—

The science of Terrestrial Magnetism has for its province the study of the magnetic phenomena of the earth. This is a science the development of which parallels the development of civilization, and has had for its votaries some of the foremost scientists of the ages.

A knowledge of the earth's magnetism is a necessity, especially since so many matters of everyday occurrence are directly affected by it. The magnetic compass is still a necessity to the mariner, to the aerial navigator, to the explorer, to the surveyor, to the miner and to the geologist. The transmission of messages by telegraph and cable is frequently interrupted by currents of electricity in the earth, and currents of electricity have a material effect on the transmission of radio waves.

Canada occupies a strategic position on the face of the earth in the eyes of scientists, since she has on her Arctic coast the magnetic north pole, and her northern territories are crossed by the curve of maximum auroral frequency.

The Dominion Observatory at Ottawa, under the directorship of Mr. R. Meldrum Stewart, has since 1907 been obtaining data on the magnetic state of Canada. Scientists are operating in the field each summer, using the most precise and delicate instruments obtainable. Magnetic stations have been from the southern boundary of the country as far north as the International Boundary on the Yukon, to the mouth of the Mackenzie, to Neultin Lake, which is within 700 miles of the magnetic north pole, to

Port Churchill on Hudson Bay, and to Nain on the coast of Labrador. Magnetic information is furnished by the Dominion Observatory to scientists of every nation to be used in a world-wide discussion of the problem of the earth's magnetism. The Dominion Observatory will, in a few years' time, have surveyed magnetically the whole of Canada, and when this has been accomplished, a valuable contribution as to the supposed motion of the magnetic north pole and the workings of the auroras will have been made to the science of Terrestrial Magnetism.

The cause of the earth's magnetism is still a mystery. The sun seems to be the cause of a number of phenomena like the auroras and magnetic storms, and is thought by some to be the ultimate cause of the earth's magnetic field. Some of the problems interesting scientists at present are:—Since the sun possesses a magnetic field, how can magnetism exist at the temperature of the sun, 12,000° F? Do all large rotating bodies possess magnetic fields? Also, do some of the properties of matter change under very great pressures as at the centre of the earth, and is susceptibility to magnetization one of them? Does the presence of sun spots affect radio transmission?

Radio came into vogue at the time of minimum sun spots, and reception was good at that time. Now radio reception is bad, and we are approaching a period of maximum sun spots. It has been surmised by some that there is a relationship between the two, but it will be years before sufficient data can be gathered so that a definite announcement can be made on this subject.

Sufficient data have not yet been collected to prove any theory of the earth's magnetism, and any theory must take into account the structure of the atom as well as the structure of the universe.

After brief remarks by the Chairman regarding the efficient scientific work performed by Dominion Civil Servants, and by Mr. Asbury regarding an educational meeting to be held in the Mechanics' Institute, a hearty vote of thanks was tendered to Mr. Madill by Mr. Crombie, and the meeting adjourned.

February 25.—In connection with the Montreal meeting of the American Physical Society, a public lecture was held under the auspices of the McGill Chapter of Sigma XI and the R.A.S.C.

Dr. W. J. Humphreys, Director of the U.S.A. Meteorological Department at Washington, lectured on "Clouds and Cloud Phenomena".

A large number of very fine slides were shown illustrative of the subject, and these were described in a non-technical manner.

Special Educational Meetings

1. March 4, 1926—Mechanics' Institute.
   Mr. Asbury: The Friendly Stars.
2. May 6, 1926—Mechanics' Institute.
   Mr. Asbury gave a lecture and showed several interesting objects through his 6″ refractor and the Honourable Justice E. E. Howard's 4″ refractor.
3. June 6, 1926—Mechanics' Institute.
   Mr. Asbury lectured, but unpropitious weather prevented the use of the small telescopes which were available.

A. VIBERT DOUGLAS, *Secretary.*

A VALUABLE CATALOGUE OF BOOKS

Messrs. Wheldon and Wesley, 2, 3, 4 Arthur St., New Oxford St., London W.C.2, have recently published an important catalogue of works on astronomy, ranging from early to recent times. There are 92 pages and 3,040 items, and many interesting books are included.

C. A. C.

The Royal Astronomical Society of Canada

OFFICERS FOR 1926

Honorary President—Hon. G. H. Ferguson, K.C., B.A., LL.D., Minister of Education for Ontario
President—A. F. Hunter, M.A., Toronto
First Vice-President—Wm. Bruce, J.P., Hamilton
Second Vice-President—R. K. Young, Ph.D.
General Secretary—F. T. Stanford, Toronto
General Treasurer—H. W. Barker, Toronto
Recorder—A. Kennedy
Librarian—Prof. C. A. Chant
Curator—Robert S. Duncan
Council—Mgr. C. P. Choquette, M.A., Lic.Scs., Montreal; J. B. Fraser, M.D., Toronto; R. A. Gray, B.A., Toronto; A. R. Hassard, B.C.L., Toronto; J. H. Horning, M.A., Toronto; Dr. Ralph DeLury, Ottawa; Prof. John Matheson, M.A., Kingston; Sir Joseph Pope, K.C.M.G., Ottawa; John Satterly, M.A., D.Sc., Toronto; Dr. D. M. Wunder, Toronto; and Past Presidents: John A. Paterson, M.A., K.C.; Sir Frederic Stupart, F.R.S.C.; A. T. DeLury, M.A.; Louis B. Stewart, D.T.S.; Albert D. Watson, M.D.; Allan F. Miller; J. S. Plaskett, B.A., D.Sc.; J. R. Collins; W. E. W. Jackson, M.A.; R. Meldrum Stewart, M.A.; and the Presiding Officer of each Centre as follows: C. R. Coutlee, C.E., Ottawa; Col. W. E. Lyman, Montreal; Rev. T. W. Morton, B.Sc., Winnipeg; Prof. P. H. Elliot, Victoria, B.C.; H. R. Kingston, M.A., Ph.D., London.

OTTAWA CENTRE

President—C. R. Coutlee, C.E.
Vice-President—H. M. Ami, D.Sc.
Secretary—A. W. Grant, B.A.
Treasurer—J. F. Fredette, D.L.S.
Council—W. W. Nichol, M.A.; J. S. Lane, B.A.; F. Henroteau, D.Sc.; and Past Presidents: R. M. Stewart, M.A.; J. J. McArthur, D.L.S.; R. E. DeLury, M.A., Ph.D.; and R. J. McDiarmid, M.Sc., Ph.D.

MONTREAL CENTRE

Honorary President—Mgr. C. P. Choquette, M.A., Lic.Scs.
President—Col. W. E. Lyman.
1st Vice-President—Rev. W. T. B. Crombie, M.A.
2nd Vice-President—H. E. Asbury
Treasurer—Prof. A. J. Kelly
Secretary—Miss A. Vibert Douglas
Council—Prof. A. S. Eve, Prof. A. H. S. Gillson, H. W. Jesmer, Justice E. E. Howard, Geo. Sample, Julien C. Smith

LONDON CENTRE

President—H. R. Kingston, M.A., Ph.D.
Vice-President—Mrs. W. E. Saunders
Secretary-Treasurer—E. T. White, B.A., D.Paed.
Council—Rev. R. J. Bowen, F.R.G.S.; T. C. Benson; Mrs. J. C. Middleton; W. A. McKenzie; E. H. McKone, B.A.

WINNIPEG CENTRE

President—Rev. T. W. Morton, B.Sc.
Vice-President—Mrs. E. L. Taylor
Curator—L. A. H. Warren, M.A.
Treasurer—Mr. H. B. Allan
Secretary—Mrs. S. C. Norris, 569 Sherburn St.
Council—N. B. MacLean, M.A., D.S.O.; D. P. Morse, C.E.; N. R. Wilson, M.A., Ph.D.; J. H. Kolb, Cecil Roy, A. W. Meggett and C. F. Ellis (*Asst. Sec.*)

VICTORIA CENTRE

Honorary President—J. S. Plaskett, D.Sc., F.R.S.
President—Prof. P. H. Elliot, M.Sc.
Vice-President—K. M. Chadwick
Secretary-Treasurer—R. G. Miller
Recorder—R. M. Petrie
Council—E. E. Blackwood, J. P. Hibben, J. A. Pearce, H. H. Plaskett, and Past Presidents: F. Napier Denison, W. S. Drewry, J. E. Umbach, W. E. Harper, M.A., and J. Duff, M.A.